Materials

Materials

This chapter discusses primary interior finish materials—their make-up, application, maintenance, appropriate uses, and consequences of selection. It begins with a discussion of common finish materials and ends with application guidelines for each.

Primary Interior Finish Materials

The following descriptions address only the most common of finish materials and cannot address all pertinent details. For more detailed information, consult general reference texts, or contact specific manufacturers.

Concrete

Concrete is a cast or poured material composed of an aggregate, typically sand or gravel, and a binder, typically cement. Concrete is extremely hard and resistant to weathering. It is most often used in areas requiring very high utility, or areas where a continuity between the exterior and interior environment is desired. Concrete is typically used in the architectural and structural definition of a space, rather than strictly as a finish material, but can be used for most any application from floors to walls to furnishings.

Masonry

Masonry, a broad material category, consists primarily of earthen building units including concrete block, clay tile, brick, and stone. Masonry walls are typically used where safety, security or durability is a primary concern or where a particular aesthetic is desired. They may also be used in solar heating applications where mass is needed for solar heat storage. Masonry walls are heavy and not easily modified. Their weight is clearly a limiting factor in some applications. They take longer to construct than a typical gypsum board partition and their cost is a premium.

Stone

Stone is a valued construction material because of its aesthetic appearance, durability and relative ease of maintenance. All three families of stone—igneous, sedimentary and metamorphic—are used in the construction trade.

Igneous stones are produced under intense heat and include **granites**. They are dense, hard and durable; may be fine or course-grained; and are found in shades of green, pink, yellow, white, and black. They may be finished in numerous ways: polished, honed, flamed, or hammered. Granite is used for wall cladding, tabletops, flooring, and other applications that require considerable resistance to wear and staining. Granite, however, is susceptible to heat and spalls when exposed to fire and so cannot be used in interior structural applications.

Sedimentary stones, such as slate and limestone, are formed by sediment deposits in the earth. These stones tend to be soft and are easily cleft and hammered. They have a limited finish availability and do not polish well or retain detail when worked. Sedimentary stones are not as durable as igneous stones. Slate ranges in color from blue to orange, is brittle, and easily splits into sheets. It is used mostly for tabletops, flooring and roofing.

Metamorphic stones such as marble, result from the crystallization of limestone. They are relatively hard, but have a venal structure which is prone to fracture. They tend to be translucent, are available in many colors, and may be polished into shiny, smooth surfaces, or honed to a matte finish. Metamorphic stones are porous and will absorb oils; therefore they must be sealed for most uses. **Marble** is used for decorative wall panels, tabletops, fireplaces, countertops, and flooring.

Metals

Metals are extremely durable materials easily formed through a number of processes. They may be drawn into wire, rolled into sheets, cast, or stamped into many useful and decorative objects. They vary in reactivity to water, oils and chemicals. Stainless steel and chrome resist most reactants encountered in interior environments quite well; therefore, wet rooms and clean

rooms commonly utilize these metals. Brass and bronze are generally given a protective coat to prevent their natural oxidation due to exposure. Finish techniques for metals include hammering, brushing, polishing, and etching. Metals can be used in ceilings and countertops as well as walls and other vertical surfaces.

Wood

Wood has been used for centuries as the primary construction material for buildings and furniture. It is a renewable material and is easy to work. Lumber quality varies, relating directly to the method of sawing, seasoning and surfacing.

Most lumber intended for use in the framing of buildings is **plain sawn**, a method of dividing the log that produces the maximum yield and the greatest economy (Fig. 1). The varying grain orientation of plain sawn lumber causes the pieces to distort during seasoning, and to have very different surface appearances from one piece to the next. Occasionally these variations may cause problems, especially for interior trim, finish flooring, and furniture. For these purposes, wood is typically **quarter sawn** (Fig. 7) to produce lumber with a more consistent vertical grain orientation and a tighter, more pleasing figure. These boards also tend to remain flat despite changes in moisture content and have an improved wearing quality.

Seasoning, either natural or kiln-processed, reduces the moisture content of lumber to a specified level appropriate for the application; for example, 19 percent or less for framing. This process is critical to the strength, dimensional stability, stiffness, and weight of the material. **Surfacing** makes a board smooth and dimensionally precise. Surfaced lumber is easier to work with because it is more square and uniform in dimension and less damaging to the hand. **Grading** of lumber is performed either for appearance or structural strength and stiffness, depending upon its intended use.

Softwoods, such as pine, redwood, and cedar, come from coniferous trees and have a relatively simple microstructure, consisting mainly of large longitudinal cells. Softwood lumber generally has a coarse and relatively uninteresting grain structure. **Hardwoods** such

as cherry, mahogany and oak, come from broadleaf trees and are more complex in structure than softwoods. They have smaller diameter fibers and larger diameter pores. For fine furniture, interior finish details and finish flooring, hardwoods are most often used. Most lumber used for building framing comes from softwoods which are comparatively plentiful and inexpensive. Other uses for softwoods are paneling, moldings, window and door frames, finish flooring, shingles, siding, and outdoor structures where decay resistance is required.

Solid wood lumber is available as either nominal or dimensional material. **Nominal** sizes are generally used to refer to lumber used for rough construction and framing. A 2x4 has a nominal dimension of 2"x4" but measures less. **Dimensional** sizes are specified for finish work where the wood is required to be a specific or minimum dimension. Solid wood lumber is unpredictable in terms of appearance and behavior: it depends largely on the natural growth of the source tree. It is susceptible to seasonal movement due to swelling and shrinking of the wood cells with humidity in the air. A primary advantage to solid wood however, is that it is homogeneous and may be thoroughly sanded in refinishing.

Wood Interiors Products

Laminated wood products—in which several layers of wood are glued together—are available for structural or finish work when solid wood lumber is neither available nor appropriate. Laminated beams allow the use of structural wood members which would not be possible or economical in solid wood. Plywood, formed of sheets of wood laminated with grain run in perpendicular directions, allows larger panel sizes and reduces distortion and warping by setting the wood structure in balance against itself. Lamination also allows a combination of woods to be used to derive maximum benefit from the characteristics of each of the component pieces. Laminated wood may be superior to solid in terms of stability and size availability, but is more limited in terms of wear due to the thinner finish face thickness.

Veneers are thin sheets or leaves of wood produced by slicing a log, usually to maximize the utility of a piece of fine wood. Veneer-faced lumber products have

essentially the same characteristics as their lumber core. They can, however, be produced very economically through a higher degree of mechanization and material usage.

Four primary veneer cuts exist: plain (or flat) sliced, rotary, quarter sawn, and rift cut. These four cuts vary significantly in their display of the wood grain and their economy of production. **Plain slicing**, the most common cut (Fig. 1 and Fig. 2), is done parallel to a line through the center of the log. A cathedral display characterizes its grain, with marked progression in graining among the

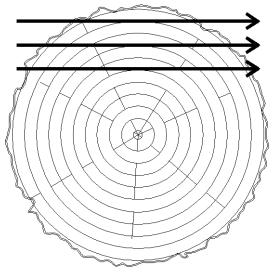

Fig. 1 Plain sawing or slicing

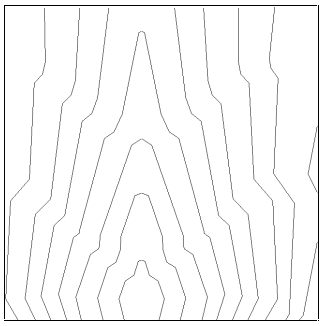

Fig. 2 Plain sliced veneer

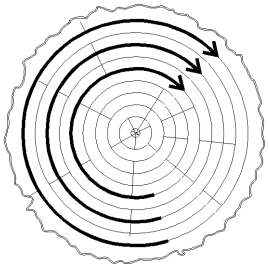

Fig. 3 Rotary slicing

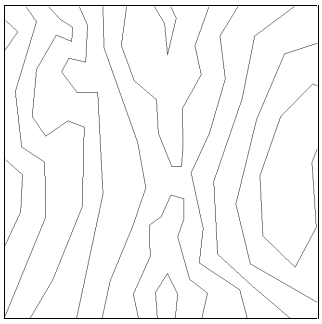

Fig. 4 Rotary sliced veneer

leaves as they approach and then depart the center of the log. **Rotary cut**, peeling the log about its core, is the most economical cut of veneer but yields a very irregular grain pattern (Fig. 3 and Fig. 4). This cut is used primarily for structural (commodity grade plywood) and paint grade veneers.

Quarter sawn veneers are one of the two premium class veneers as veneer leaves tend to be small and the loss of log considerable (Fig. 5 and Fig. 6). By cutting the log into quarters and then slicing, a narrow striped grain pattern is revealed, and the cross-growth structure of the

wood is accentuated, resulting in a display of the medullary rays in wood species such as oak. (It is these

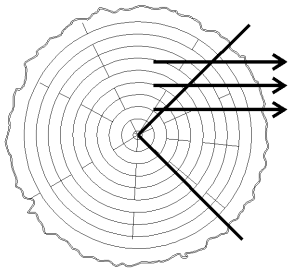

Fig. 5 Quarter sawing or slicing

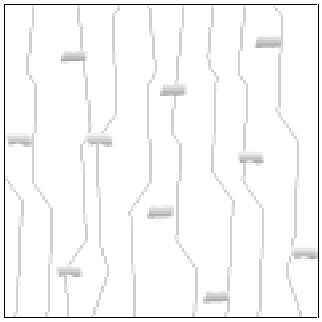

Fig. 6 Quarter sliced veneer

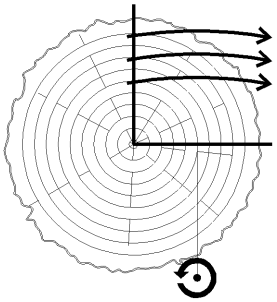

Fig. 7 Rift slicing

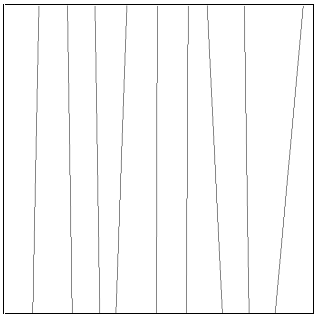

Fig. 8 Rift sliced veneer

medullary rays which give Mission oak its characteristic grain pattern.) **Rift cut** veneers produce the most controlled grain patterns, with narrow striped graining and reduced display of the medullary rays (Fig. 7 and Fig. 8).

Veneer Matches

Matching of wood veneers is performed with the ordered leaves taken from a single or multiple logs. As leaves are cut from a log, they are held in sequence for later assembly into veneer sheets. In **book matching** every other veneer leaf is turned over, resulting in the greatest

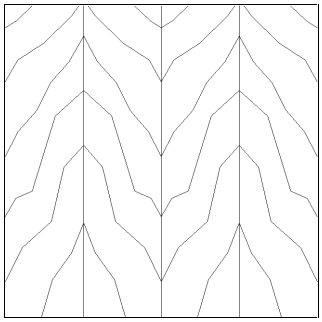

Fig. 9 Book match

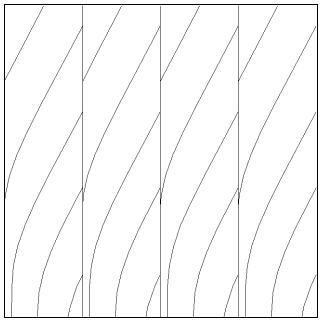

Fig. 10 Slip match

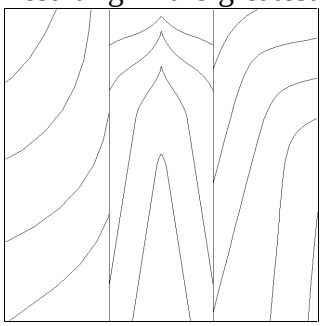

Fig. 11 Random match

continuity of grain pattern as the log is essentially unfolded (Fig. 9). This type of match is most common

for plain sliced leaves where considerable breadth of pattern occurs. The fact that alternate interior and exterior faces of the veneer are displayed results in an additional, subtle variation as the direction of the pores in the grain alternates up and down from leaf to leaf. This may be aggravated through improper finishing, and may cause a color shift as the reflective surface of the wood changes.

Slip matching fans the leaves of a log as one might fan a deck of cards (Fig. 10). This provides a strong continuity of grain and color match, but results in a very directional pattern. This match is best used with rift and quarter sawn veneers where the grain is controlled during the cutting process. **Random matching** means just that: the veneer leaves are placed randomly, purposefully placing the veneers out of order (Fig. 11). This is sometimes done for aesthetic effect, but most often is simply an economical means of mixing leaves from multiple source logs.

Industrial composite boards, such as **medium density fiberboard**, **wafer board** or **oriented strand board**, are **engineered wood products** developed to take advantage of very specific characteristics of wood. They are often made from commodity woods - fast growing trees with little aesthetic character or utility due to their small size, but which, as raw material, provide an excellent source of product. Industrial composite boards are typically engineered with a particular use in mind, and their application must be consistent with that intended use. They vary in stability, resistance to moisture and workability - some are intended as finish materials while most are only used as substrates.

Plastic

Plastics exist in many forms, including rigid sheets of solid plastic, plastic laminate veneers over hardboard panels, or thin and flexible wall vinyls. These materials come in a wide range of colors and surface finishes and are durable and generally easy to clean. However, some may be damaged by abrasive cleaners, and once damaged may be difficult to restore to their original finish.

Plastics may be used as an alternative to glass where impact is a concern. Solid plastics for countertops, transaction surfaces, and toilet partitions offer workability and repairability. Thin plastic veneers provide an economical protective wall treatment.

Plastic Laminate

Plastic laminates traditionally consist of a decorative paper face sandwiched between a phenolic backing and a melamine face. Recent product developments have led to solid-color laminates composed of multiple layers of colored paper imbedded with melamine so that the color continues through the thickness of the laminate. Plastic laminates are used extensively for cabinets, countertops and tabletops.

Plastic laminate grades are as follows.

- GP 50, General purpose used for horizontal applications; offers sturdiness and good wear resistance and can be cold formed in simple bends to radii of 6 to 8 inches.
- GP 28, General purpose, a thinner material produced for vertical surfaces exposed to less wear.
- PF 42, Post-forming can be bent at elevated temperatures to small radiuses and has a permanent memory for the formed position.
- CL 20, Cabinet liner for vertical decorative surfaces that receive little wear, such as insides of cabinets.
- BK 20, Backer used in the fabrication of plastic laminate-clad surfaces to prevent warping and to protect against dimensional instability of both the laminate and substrate.

Glass

Glass has myriad uses as partitions, tabletops and windows. Available in a wide range of thicknesses, glass may be laminated where additional strength or thickness is required. Standard utility glass is annealed. In many interior applications - particularly where the glass is susceptible to impact or required to be part of a fire-rated enclosure - safety glass is required. Safety glass is available in three common manufactures: laminated, tempered and wire glass.

Laminated safety glass is composed of two or more sheets of glass with plastic interleaves, bonded together through heat and pressure. When broken, the plastic holds the fragments of glass together to help reduce injury. It is important to note that not all laminated glass is safety glass; a number of manufacturers produce decorative laminated glass. **Tempered glass** is heated and then cooled rapidly to alter the molecular structure of the glass. When broken, tempered glass shatters into tiny rectangular fragments, reducing risk of harm from the broken glass. **Wire glass**, like laminated glass, has an independent structure introduced into the glass to maintain its integrity in case of damage; in this case a wire mesh imbedded into the molten glass during forming. Wire glass is commonly used only in fire-rated enclosures where this integrity is paramount. However, its appearance is often objectionable.

Glass may be used for decorative purposes as well. By etching or sandblasting the surface, or using patterned or colored glass, different optical effects can be achieved. Decorative laminated glasses offer almost limitless options for altering the appearance of glass to achieve different colors or patterns. Many types of glass have limited applications: art or stained glass, electronic (LCD) privacy glass, polarized glass, fire resistive (salt-filled) glass, and bullet resistive glass. These specialty glass types need to be researched independently for their specific uses.

Wall Board

Wall board is perhaps the most common of all contemporary building materials. Essentially a wafer of gypsum (a powdery white mineral) sandwiched between two layers of paper, gypsum wall board is a mass-produced replacement for plaster and lath. When the appropriate grade of wall board and finish are used together, this product has extremely broad applications. It is generally secure, easily maintained and provides a level of fire and moisture protection.

The different grades of wall board include:

- standard grade for general application,
- fire resistive for use in fire resistive construction,
- water resistant for use in damp locations, and

- cementitious for use in wet locations (such as shower enclosures or as tile underlayment in kitchens, etc.).

Tile

Tile may be used as a wall or floor finish for both interior and exterior applications. It is very durable, easily maintained and attractive. Tiles are available to coordinate in color, style, texture, and thickness with other floor coverings.

Ceramic tile is made of clay that is shaped and fused by firing in a kiln. They generally come in tiles 300 mm (12 inches) square or smaller, and can be easily installed with mastic over any rigid substrate. Because of its hard surface, glazed ceramic tile can be easily cleaned and is quite resistant to stains, making it appropriate for wet areas such as bathrooms, kitchens and laboratories.

Porcelain tile is a dense, fine grained, smooth, homogeneously colored ceramic tile. It resists chipping and provides superior stain and slip resistance.

Quarry tile is typically a thicker tile with a rougher character than either ceramic or porcelain. It is impervious to water, grease and most liquids, and wears well. Quarry tile is often used on floors that are subject to a great deal of abrasion.

Terrazzo

Terrazzo, similar to concrete, consists of an aggregate bound in a matrix, but is not a structural material. It is usually applied over concrete and divided by zinc, brass, or plastic cames into workable areas and patterns. The aggregate may be any hard material such as marble, rock or glass while the binders are typically cementitious or epoxy-based. Terrazzo is a designed surface composed of aggregate and matrix chosen for their color, texture and translucence. A polished finish is the most common; however, it may be left unpolished. Terrazzo is most frequently used for floor finishes requiring a high level of durability and low maintenance.

Acoustic Ceilings Systems

Suspended **acoustic ceiling systems** refer to acoustic panels or tiles suspended by an exposed or concealed ceiling grid. The tiles themselves can be made of fiberglass, mineral fiber, wood, or metal. They range from smooth, washable surfaces to deep-fissured or textural patterns. They come in a wide range of patterns, colors, and acoustic values—most between 0.50 and 0.70 NRC. The quality of the acoustic value directly relates to the composition, face texture, and manufacture of the tile. Fiberglass tiles absorb almost all of the sound that strikes them but are generally not very durable. Mineral fiber tiles are more durable and absorb less sound overall than fiberglass, but they prove very effective at absorbing sound that strikes at a 90 degree angle. As the angle of incidence increases however, the sound absorption decreases.

Acoustic ceiling systems are utilized for their cost efficiency, flexibility and acoustic properties. These systems can be used in almost any application. Caution should be taken to specify moisture resistant systems in wet areas.

Resilient Flooring

Linoleum was the first resilient flooring that gained broad popularity. Schools and public buildings with heavy duty needs still utilize linoleum as a resilient floor covering. Thicker linoleums can be warm and resilient. Disadvantages to linoleum are its sensitivity to alkalis, and susceptibility to water damage from underneath, which can cause it to bubble, peel or deteriorate.

Cork provides a very resilient and acoustic option for flooring. Inherently porous and fragile, cork is typically combined with resins to increase durability. The increased durability far outweighs the minimal loss of acoustics and resiliency with the addition of resins.

Vinyl Composition Tile (VCT) is composed of vinyls, resins, plasticizers, coloring agents, and fillers. VCT is resistant to oils, grease and other stains. It is very economical, wears well and is easily maintained, repaired, and replaced. Disadvantages include its

vulnerability to scuffing and marking, and continuous care required to maintain its visual appearance.

Sheet vinyl is waterproof, resists most domestic chemicals and can have a textured finish that is slip resistant. It is resilient, quiet, shows fewer marks than VCT, and can be cushioned. Sheet vinyls come in an unlimited range of colors and designs and can be used with underfloor heating. Solid colors are not recommended in high-use areas because they tend to show dirt and marking.

Rubber, possesses many of the same properties as vinyl; although it is more resilient and resistant to indentation than vinyl. It will withstand wear and spiked shoe traffic longer than any other type of resilient flooring. Rubber flooring with raised patterned surfaces is ideal for areas where excessive tracking of dirt or moisture is likely, because the dirt and moisture drop below the wear surface. Unfortunately, rubber is less resistant to grease, oil and alkalis than vinyl, and is not available as a conductive flooring.

Static-conductive tiles are specialty tiles with an additive to enhance the dissipation of static electricity. These tiles are frequently used in hospital operating rooms or laboratories where sparks may pose a hazard.

Carpet

Carpet comes in a wide range of colors, patterns and textures. Carpet aids in reducing fatigue from standing for long periods of time and absorbs noises within an interior. It is inherently slip resistant but provides a soft surface in case of a fall. Considerations when selecting carpet include type of fiber, construction and cleanability.

Carpet can be made from many different types of yarn, and further from different fibers within those yarns.

Fiber Types

- **Staple fibers** are relatively short in length and must be carded and spun in order to form yarn. Natural fibers such as wool, cotton and flax are staple fibers. Synthetic fibers are sometimes cut into staple fibers.

- **Continuous filament fibers** are produced as single running fibers. Typically nylon and other man-made

fibers are continuous filament. Silk is a natural continuous filament fiber.

Fiber Composition

Nylon is the most common type of fiber used in commercial carpet. Nylons may be dull or glossy and have good color range. Nylon is very tough and easily cleaned, and it blends well with other fibers. The more advanced nylons have inherent static control and excellent resistance to mold, mildew, aging, abrasion, and sunlight. Unfortunately, nylon does attract dirt and melts on contact with direct flame.

Wool, a natural fiber, is warm, soft, fire and mildew resistant, has a hard-wearing resiliency, and dyes well in a wide range of colors. It has a high resistance to soiling and wear as well as excellent texture and appearance retention. However, dampness may cause wools to swell, and dry heat may cause shrinkage.

Continuous filament **olefins** are used in backings for tufted carpets. They are hard-wearing, easy to clean, and resistant to water, mildew, soil, stain, aging, abrasion, and sunlight. A major disadvantage of this fiber for face yarn is that the material crushes and pills easily, making it undesirable for commercial use.

Dye Processes

Yarns may be colored at several stages during the manufacturing process. Synthetic yarn which has color added to it prior to the fiber-forming process is called **solution-dyed**. Synthetic or natural yarns colored after being formed are called **yarn-dyed** or **skein-dyed**. Yarns colored after the carpet has been manufactured are referred to as **piece-dyed**.

Solution-dyed yarns hold their color best because the color is integral to the yarn and thus not subject to removal by cleaners or bleach. Because the dye is contained within the body of the yarn however, the color is dependent on the color and clarity of the base yarn material, and is usually muted. Because the various colors of yarn are made individually, they are generally produced in smaller batches than yarn which is to be skein or piece-dyed, and are therefore more expensive than these goods.

Because the pores on the surface of skein and piece-dyed yarns are already filled by dye, they tend to be more resistant to staining than an untreated solution-dyed yarn.

As the dye rests on or near the surface of skein and piece-dyed yarns, their color is generally more brilliant as well.

Both solution and yarn-dyed carpets offer excellent opportunity for color mixing. Because the entire carpet is subjected to a single dye for piece-dyed goods, color is dependent on the yarns' ability to absorb or resist the dye, and is therefore much more limited.

Another opportunity to introduce color and pattern to a carpet is through overprinting. Overprinting is a localized dye process whereby dyes are applied to the face of a carpet, or injected into its pile. Limitations to this process are depth of ink penetration, color resistance to cleaning, and lack of definition in pattern due to bleeding or wicking of the dyes along and between yarns. Overprinting has its broadest applications in the production of less-expensive custom pattern carpets and remanufacturing. (In remanufacturing, the face of a used carpet is sheared slightly, and then the carpet is overprinted to update its look and conceal minor flaws and damage.)

Carpet Format

The term **broadloom** originally referred to woven carpets which were made on a loom, but now describes most rollgood carpets. Broadloom carpets are available in a variety of widths, the most common of which are 1830 mm (6 feet) and 3660 mm (12 feet). Use of a broadloom carpet requires the development of a seaming plan prior to installation to ensure that seams are located inconspicuously and never in the middle of high traffic areas. Disadvantages of broadloom carpet include inconvenience of access to underfloor systems and difficulty in replacing damaged areas.

Carpet tile is manufactured as a rollgood and then cut into squares of 305 mm (1 foot) to 1220 mm (4 feet) dimensions. Installation by glue-down or loose-lay methods are possible. Replacement of damaged or worn tiles is quite simple. Other advantages include reduced waste of goods at installation and easy access to underfloor systems. Initially carpet tiles cost more than broadloom, but life-cycle cost may be less, if reconfiguring or replacement of small areas is significant.

Tufted carpets are made up of individual tufts of yarn inserted into a premanufactured jute, cotton or synthetic backing (Fig. 12). A coating of latex applied to the back of the carpet bonds the tufts to the backing.

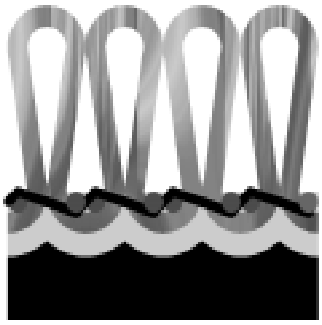

Fig. 12 Tufted; loop carpet

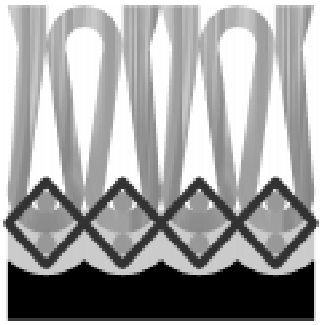

Fig. 13 Woven; cut and loop carpet

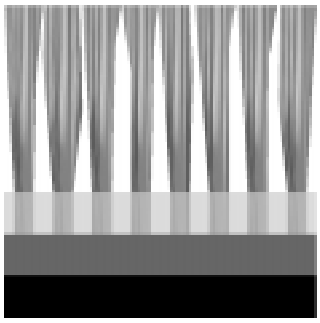

Fig. 14 Fusion bonded; cut pile carpet

Carpet Construction

In the **woven** carpet manufacturing process, the yarns for the backing are woven simultaneously with those of the face (Fig. 13). The primary components of a woven carpet are the weft yarns, backing yarns which run the width of the carpet; the warp yarns, backing yarns which run lengthwise through the carpet; and the pile yarns which form the face of the carpet. The three principal machine-woven techniques are: velvet, Wilton and Axminster. **Knit** carpet is a type of woven carpet in which the pile yarns are interwoven among themselves, resulting in a three dimensional weave.

Carpet Face Types

In **fusion bonded** construction, pile yarn is inserted directly into liquid vinyl backing which is then fused at a high temperature to lock in the yarn, creating a unitary structure (Fig. 14). In some manufacturing operations, the yarn is sandwiched between two backs, and cut after curing to form two separate runs of carpet. Fusion bonding provides high tuftbind and density, maximizes face yarn utility on the wearing surface, and minimizes edge fraying or raveling.

All face yarns in **cut pile** (Fig. 14) carpet are cut. The carpet then has a plush, velvet look. Cut pile hides seams and cuts well, and responds favorably to easy, periodic maintenance. It can be produced in fusion-bonded, tufted or woven construction. Low density cut pile carpets show crushing and shading, and should be avoided where this is a concern.

No surface ends are cut in **loop pile** carpet (Fig. 12). Loop pile can be produced in tufted or woven construction. It is very durable, not affected by crushing, and is easily maintained. Pilling can occur with staple fibers. Loop pile carpeting does not hide seams or cuts well due to blossoming of the yarn at locations where the loop has been cut.

Tip shear and **cut and loop pile** are combination face construction carpets which provide some of the benefits of each of the previous types of face construction (Fig. 13). Tip shear is produced as a multi-level loop carpet and then sheared to a single height. Cut and loop is cut during the weaving or tufting process. These carpets provide a softer look than all-loop pile, but are more durable than cut. They do not hide seams and cuts as well as all cut pile, but do better than all loop.

Backing Systems

Backing systems are enhancements to the construction of a carpet to ensure stability and integrity of the carpet. All woven and tufted carpets are constructed over a primary backing. **Primary backing** refers to the material the pile yarns are woven or tufted into during the process of manufacturing. While some woven carpets are heavy enough to require only primary backing, tufted carpet requires additional support.

Secondary backings improve the body of the carpet and its dimensional stability, anchoring the pile yarns to better prevent slippage. A **scrim coat** of latex is often applied to the back of a carpet to lock the yarns into place and is the basis for all additional backings. The **action-back** system consists of the carpet pile yarns and their primary backing with a latex pre-coat and a woven secondary backing laminated to it. One of the most common backing systems, action-back improves tuftbind, helps prevent delamination and is applicable to any type of carpet.

The **unitary backing** system consists of pile yarns and primary backing with a high performance latex or PVC coating to lock the yarns in place. This backing gives a higher tuftbind than action-back and prevents edge ravel, delamination and zipping. While unitary backing allows for better performance in high traffic areas, it is only used on all-loop pile carpet.

A **unitary action-back** has all the benefits of the unitary backing. The added secondary backing allows not only loop pile but also tip-sheared loop and cut and loop carpets to use it.

Padded backing is available in a number of formats and thicknesses. Padding is typically applied directly to the carpet to reduce the labor involved in installation, and to provide additional stability and integrity to the carpet as a form of secondary backing.

Installation Methods

Direct glue installation secures the carpet directly to the floor. The adhesive may be permanent or, for carpet tile, releasable. Releasable glue is used when periodic access is needed for gaining access to the underfloor systems. Direct glue is generally the most economical means of installing broadloom carpet. It provides an extremely stable carpet base suited to heavy traffic.

Stretched installation works well in light to moderate traffic areas. Perimeter fastening devices are installed which hold the edges of the carpet only, facilitating easy removal of carpet for relocation, replacement or access to the floor. These devices are generally either tack strips consisting of rows of metal barbs which bind the carpet backing, or fabric hook tape which binds special loop backing applied to the carpet during manufacture. Alternatively, the carpet may be tacked directly to the flooring, as is often the case when carpeting wooden stairs or other small or irregular areas.

Free lay installation is used primarily on carpet tile but may be used on other carpets with semi-rigid backing. Even in free lay installation, a grid of adhesive is generally necessary to prevent the field from shifting under load. This grid is typically 3.66m (approximately 12 feet) on center.

Carpet Pad

Carpet pad provides additional softness and extends carpet life by yielding with the pile under load. Various types of pad are available, made from natural fibers, urethanes and rubber. Some pads are separate roll goods installed prior to the carpet, others are specially designed integral pads specific to the application.

Carpet Cleaning

Various cleaning methods are available for carpet. The particular method used should be chosen on the basis of the installation and the nature of the soiling.

Feature	Characteristics
Material	
Nylon	Good resiliency. Very good resistance to abrasion, crushing, matting, moisture, staining and soiling. Requires addition of anti-static fibers for static control. Appropriate for heavy wear areas.
Olefin	Poor resiliency. Good abrasion and matting resistance. Very good mildew, staining, soil and moth resistance. Not prone to static build-up. Best used in indoor/outdoor and short term applications. Not recommended for interior commercial or institutional installations.
Wool	Excellent resiliency. Very good resistance to abrasion, crushing, matting. Fair resistance to moisture, staining and soiling. May be treated to reduce static electricity build up and moth damage. High initial cost.
Dye Process	
Solution-Dyed	Color is added prior to formation of fiber, and is therefore inherent to the material. Color consistency is optimal. Color is as resistant to chemicals as yarn. Porous fiber face—if not stain treated— allows retention of dirt and stains.
Yarn-Dyed	Most brilliant color. Color is added to the bulk yarn prior to the carpet manufacturing process. By mixing yarn during manufacture of the carpet, small color differences may be concealed. Pigment fills porous fiber face, and reduces staining. Pigment is susceptible to damage from chemicals and abrasion.
Piece-dyed	Carpet goods are dyed after manufacture. By mixing yarns of different dye resistance properties, multiple colors can be achieved. Some color variation through the carpet may be apparent due to the dying process. Pigment fills porous fiber face, and reduces staining. Pigment is susceptible to damage from chemicals and abrasion.
Overprint	Used to add pattern to a carpet after manufacture. Color penetration varies by manufacturer. Some may be very shallow, and as a result will not wear well.
Construction	
Tufted	Low cost manufacture. Quality depends largely on the ability of the carpet to retain tufts. Tuft bind may be considerably enhanced by added backing.
Woven	Premium manufacture. Quality related primarily to carpet density. Wide variety of patterns available with different weaving processes.
Fusion Bonded	Very durable carpet construction. High tuft bind. (See also Unitary backing below.)

Fig. 15 Carpet Selection Criteria Table of Common Carpet Features

Feature	Characteristics
Face Construction	
Loop	Most durable of constructions. Resists matting and crushing. Typically matte in appearance as side of fiber is exposed.
Cut Pile	Rich in appearance. Hides seams well. Prone to crushing and matting. Carpet density and pile height together determine quality of product. Low-density product tends to lay over and show traffic. Not recommended in heavy traffic areas or stairs.
Cut and Loop	Aesthetic variation on the two face constructions listed above. This construction allows greater variety in surface appearance, while balancing, in some measure, the durability of a full loop carpet.
Format	
Broadloom 2-4m wide	Long lengths produce fewer seams, and therefore the appearance of seams is a lesser consideration. May be padded. Limited access to floor. Difficult to repair. Large scale custom patterns require excellent craftsmanship.
Carpet tile 0.5-1.33m square	Relatively easy installation. Large scale patterns are relatively simple to achieve. Floor access is maximized. Stains and wear are easily repaired. Seams are abundant.
Backing	
Primary Scrim	Scrim coat of latex applied to back of carpet over tufted ends or weave. Increases tuft bind over non-backed. Enhances adhesion of direct-glue carpets.
Action back/Secondary backing	Additional fabric backing applied over primary scrim. Improves tuft bind, dimensional stability.
Unitary backing	Built-up latex or PVC backing. Excellent tuft bind and dimensional stability. Substantially reduces potential for edge ravel.
Padded Backing	Reduces labor of installing backing separately. Some hybrid benefits of other secondary backings.
Installation	
Direct Glue	Economical installation for broadloom carpet. Very stable. Difficult to remove. Typically no material value after removal. Glue-down of tile products is required by some manufacturers.
Stretch	Broadloom only. Seams are taped or sewn. Large expanses of carpet are difficult to stretch. Carpet may move with weather conditions.
Free lay	Carpet tile only. Easily installed, easily repaired. Provides immediate access to subfloor. May move if not properly installed

Fig. 15 (cont'd) Carpet Selection Criteria Table of Common Carpet Features

- The **dry extraction** procedure utilizes an absorbent powder or other component which is worked into the carpet pile and then vacuumed out. The soil-extracting particles used in this method are generally water-based detergents with a small amount of solvent. The advantage of dry extraction cleaning is that the fibers do not get wet. This alleviates the need for drying which may cause shrinkage, and eliminates the potential for mold or mildew growth.

- The **dry foam** method utilizes a water-based shampoo converted into foam. This is worked into the carpet and then vacuumed out. Cleaning with dry foam may not be as thorough as other methods, especially when large amounts of soil are deeply embedded in the pile layer. The risk of overwetting is minimal.

- The **wet shampoo** method utilizes a wet vacuum to draw fluids and dry matter from surfaces. Rotating brushes work the detergent solution into the carpet. This may cause pile distortion, especially to cut pile surfaces. This procedure must be administered carefully to avoid overwetting the structure and to prevent accelerated resoiling due to residual detergent deposits.

- The **hot water extraction** method, commonly called steam extraction, uses extremely hot water and shampoo. The diluted shampoo is driven into the pile and immediately extracted by the vacuum part of the machine. Minimal pile distortion occurs as there is no mechanical brushing. The detergent must be thoroughly removed to retard rapid resoiling.

For extremely soiled carpet, a heavy build up of residue may require removal with a combination of the above methods

Stain Penetration

In general, staining and spotting may be prevented by acting promptly: foreign substances are more difficult to remove after they have aged. Vacuuming dry substances, and absorbing as much liquid from wet ones as possible before continuing with other removal procedures, is key to avoiding stains. Having cleaning agents and materials available for immediate use as part of proper general maintenance will extend a carpet's life.

Paint and Other Film-Applied Finishes

Paint is, in generic terms, a suspension of solid pigment in a liquid, which is applied to a surface, and which then cures or dries to leave a thin film coating. Paints are available in limitless color choices. They are classified by their liquid portion—the vehicle. Paints are typically either water or oil-based.

Types of Water-Based Paints

Water-based paints have synthetic resins and color pigments suspended in water. Because they are water-based they are typically easier to handle than oil-based paints and clean up readily. The alkaline resistance of these paints makes them suitable for new lime-containing plaster. Acrylic emulsions make the dried film more water-resistant while vinyl emulsions give it a smoother finish. Water-borne paints dry quickly, but raise the grain on new wood. Most are not as tough or washable as oil-based paints.

Types of Oil-Based Paints

Oil-based paints may consist of natural or synthetic resins, color pigments, linseed oil, and solvents. They are extremely durable and washable, especially if made with synthetic resins.

Oil-modified resins, **alkyds**, have now replaced the traditional oil-based paints. Alkyds prove more durable and dry faster than typical oil-based paints. Alkyds apply easily and are priced moderately, but some disadvantages do exist. Exterior alkyds have poorer sheen and color retention than exterior latex or acrylic paints, and tend to yellow over time. A primer must be used on alkaline surfaces before an alkyd is applied. Although some alkyds have no odor, fumes may be toxic and highly flammable until the surface has dried. Clean-up requires mineral spirits and is more difficult than with water-based paints.

Formulations

Latex paint applies easily, has low odor, dries and recoats quickly, poses minimal fire hazard, and resists peeling and blistering. Latex paint is water-based and cleans-up with soap and water.

Acrylic paint is lightweight, strong, and has good color and optical qualities. It is resistant to weather and temperature. It is available in both oil and water-based preparations.

Epoxy paint is typically a two-part preparation that produces a tough, hard, glossy finish. It works well for wet areas, and high traffic areas such as stairwells. It is waterproof, has excellent sealing qualities and resists specific acids, alkalis, gases, salts, and solvents. It is available in both oil and water-based formulations.

Finishes

A **flat** finish has a dull, non-reflective surface that may be wiped but not scrubbed. It shows scuff marks easily and has little sealing capability, making it inappropriate for damp areas.

An **eggshell** finish has a slight reflectance and sheen. It is easily cleaned by wiping and will not show scuffs marks as readily as a flat finish. It can be used in moderately damp areas and is suitable for wood and metal.

Semi-gloss has more reflectance and sheen than an eggshell finish. Its glossy finish makes it durable and quite washable. It is normally used on woodwork and wet areas such as bathrooms, kitchens and laboratories.

High-gloss finish has high reflectance and sheen. It has a very durable, tough finish that cleans easily and resists marking and scuffing. Its good sealing qualities make it especially good for wet and damp areas, doors, woodwork, and trim; wood or metal.

Paint can be used in a variety of ways to create pattern and texture. Paint can be applied in patterns with stencils or by masking. Stippled, spattered or sponged textures can be created which utilize multiple colors and minimize appearance of spots or scratches. More-pronounced textures may be created with special paints that contain sand or other bulk; or by applying the paint with special rollers; or by going over wet paint with a sponge, dry brush, comb, or broom.

Other Surface Finishes

Specialty coatings include common multi-colored speckled finishes, textured coatings, and high-build elastic coatings. These finishes possess unique attributes with attendant benefits such as durability, safety, and appearance. They should be investigated thoroughly relative to the specific application intended to ensure appropriateness of use. Typically they require a specially-trained installer.

Lacquer is a solvent-based paint applied in multiple coats, typically with a spray gun. Lacquer may or may not have pigment and is typically used in the finishing process of commercial wood furniture and cabinets. Lacquer is highly combustible, and if not properly handled, presents a health hazard to the user.

Varnish refers to a family of colorless films used to finish wood and wood furniture. It provides a hard surface meant to protect wood from wear, while allowing the natural beauty of the wood grain to show through. Linseed oil varnishes are the traditional varnish. Polyurethane varnishes, made from a synthetic resin, are resistant to water and alcohol. Acrylic urethane varnishes do not yellow or change color as much as conventional varnishes.

Type	Characteristics
Acrylic	Excellent adhesion. Fast drying. Non-yellowing, good color retention. Resists weather and temperature. Low abrasion resistance. Low odor. Water clean-up.
Latex	Applies easily. Moderate leveling. Fast drying. Low odor. Moderate cleanability. Breathes to resist blistering and peeling. Water clean-up
Alkyd	More durable than traditional oil-based paints. Harder than latex or acrylics. Dries faster than traditional oil-based paints, much slower than latex or acrylics. Levels well. Easily cleaned. Tends to yellow and chalk over time. Flammable and strong odor until dry. Requires thinners for clean-up.
Epoxy	Very durable. Resistant to abrasion and many chemicals. Typically high-build. Flammable and strong odor until dry. Recommended for wet areas. Requires thinners for clean-up.

Fig. 16 Paint Selection Table for Common Paints

Stain is similar to paint, but does not form a sealing film so much as it penetrates the structure of the surface it is applied to. It can be transparent or opaque, and is available in a limitless range of colors. Several different types of stains are available. Oil-based, water-based and alcohol-based stains are typically covered with a protective coat of oil or water-based varnish. Alcohol-based stains are typically used under lacquer. Varnish stains provide a superficial colored protective surface. This type of staining method is cheap and fast but does not have the depth of color of other stains. Stain waxes

provide pigment as well as the protective finish of a wax.

While paints, lacquers, and varnishes are all appropriate surface finish materials, recent legislative **Volatile Organic Compounds** (VOC) regulations have led to the development of a new generation of higher-performing, easy-to-maintain top coats for finishing systems. These include high solids and water-reducible varnishes, lacquers, and polyurethanes. These superior quality, low VOC, high-build finishing systems provide excellent toughness, domestic chemical resistance and exceptional durability.

New VOC compliant, high-quality acrylic, and clear lacquer systems provide good film clarity, hardness and excellent resistance to yellowing. They are used in low traffic areas. High solids, low VOC polyurethanes offer impact, abrasion, chemical, and stain resistance as well as excellent hardness, while providing good color.

Wallcovering

Applied wall finishes, excluding paints, fall under the umbrella term **wallcovering**. These range from vinyls and papers to textiles of varying types.

Vinyl wallcoverings are durable and resist grease, stains and cooking splashes quite well, are scrubbable and easy to clean. Vinyls can be backed with a woven fabric to increase their durability and to cover rough subsurfaces. Vinyl wallcoverings come in a wide range of designs, colors and finishes. They are suitable for use in kitchens, bathrooms and most commercial installations.

Wallpapers are produced for residential and light commercial use in a wide variety of colors, textures, patterns, and pictorial images. Many wallpapers have a self-adhesive or prepasted backing for ease of installation. Papers are not intended for moderate to heavy use commercial installations. Wallpaper is not as durable as vinyl wallcovering and deteriorates more rapidly in the presence of moisture.

Textile wallcoverings come in many styles, textures and colors. They consist of a fabric face backed with paper. Silk, linen, wool, sisal, jute, nylon, and olefin can all be used. Textiles add softness, texture, color, visual

interest, and may add acoustic properties and durability to a wall surface. They do not all resist abrasion and snagging well and some are prone to soiling. These wallcoverings should be avoided in heavy traffic areas.

Fabric and Textiles

In this discussion “fabric” is used to indicate a finished material piece, and “textile” the raw material from which the fabric is made, or a general class of fabrics.

In selecting fabric for furnishings and drapery, each consumer or producer will use a unique set of governing criteria. These factors vary but usually relate to appearance, feel, and/or durability of the material. The following describes some of the appearance and durability factors associated with fabric selection.

Because fabrics possess both visual and tactile attributes, the designer must be knowledgeable about the textile characteristics associated with these qualities. Pattern, color, and texture of a fabric will affect how it will appear alone and in combination with other elements in the interior design.

Color characteristics of individual textiles and textile combinations must be considered when selecting fabrics. Other aspects associated with color styling—multi-colors, solid-colors, motif, detail, and pattern size—will also affect the appearance of fabric design.

Hand, **drapeability**, and **weight** must be considered when choosing a fabric. These qualities are associated with the psychological response of users to the material. The characteristics of hand (smooth, rough, cool, soft, or harsh), drapeability (stiff or fluid), and weight (sheer, thin, light weight, medium weight, or heavy weight) are all critical factors that need to be considered in fabric selection.

Durability depends on the basic life of the fibers that make up the fabric. Among the general factors defining durability are resistance to wear and dirt, ease of cleaning, and ease of repair. Other factors that may be specifically related to a fabric or textile's durability include:

- tenacity (resistance to tearing),
- stain resistance,

- abrasion resistance,
- cohesiveness (ability of a staple fiber to retain its spun form),
- elongation potential/elasticity,
- flexibility,
- structural stability,
- fiber strength,
- moisture/mildew resistance, and
- flame resistance.

Maintenance factors to be considered when selecting fabrics and textiles.

In order to preserve a fabric's appearance and durability, it must be maintained over time. The maintenance required of a chosen fabric must coincide with the consumer's preferences and willingness to perform the necessary procedures. Among the characteristics to consider when selecting a fabric are:

- cleanability, washability and dry-cleanability,
- on-site versus off-site cleaning availability,
- ease of stain removal,
- level of ironing required, and
- frequency of cleaning required.

As mentioned above, many costs are associated with the selection of different types of fabrics. Costs involved not only include the initial manufacturing or retail price, but can also include shipping and delivery charges, maintenance costs, additional treatment costs, and custom coloring and design costs.

Fabric Types

Fabrics fall under two main categories: natural and synthetic. **Natural textiles** are those fabrics constructed from materials occurring in nature. These include wool, silk, cotton, rayon (from wood pulp), and linen. **Synthetic textiles** are those constructed from man-made, primarily petroleum-based, products. These include nylon, polyester, olefin, and acrylic.

Textile Characteristics

Color retention/color fastness is important aesthetically to the appearance of a textile. The factors that influence color fastness are:

- chemical nature of fibers,
- chemical nature of dyes and pigments,
- penetration of dyes into the textiles, and
- fixations of dyes or pigments on or in the textiles.

The coloring agents used in fabrics should resist the washing, dry cleaning, bleaching, and spot and stain removing techniques used to maintain the fabric's visual appearance.

Abrasion resistance is the ability of a textile to withstand the rubbing or abrasion of everyday use. This rubbing or abrasion may occur when a fabric or textile is rubbed, flexed, or folded. The more flexible the fabric or textile, the greater the ability to bend repeatedly without breaking.

Stain resistance is the ability of a textile to withstand stains and spotting. Minimizing and removing stains is an important preventative activity that must be done to maintain the durability and appearance of a fabric over time.

Dimensional stability refers to the ability of a textile to retain a given size and shape throughout use and care. A desirable property for fibers that contribute to the textile properties of shrinkage resistance, elastic recovery, durability, and appearance; dimensional stability is especially important when choosing a method of cleaning.

Fabric Performance Enhancers

Fabrics utilize **backings** to reduce heat transfer, alter appearance, lock yarns in place, and minimize air and water permeability. Among the materials that may be used for this purpose are acrylic, foam, vinyl spray, paper, gypsum, spunlaced or spunbonded fabric, or metallic foil coatings.

Paper backing applied to the back of a textile fabric helps to prevent the application adhesive from seeping

through and producing a stained appearance. **Spunbonding** converts thermoplastic filaments directly into fabric structures. Filaments are arranged into a thin web and then stabilized with heat or chemical binders. Spunbonded fabrics are increasingly used for backings for wallcoverings and carpet. **Acrylic backing** involves using foam to minimize air movement through fabric, to increase thickness of fabric, and to finish the back of the fabric.

Backcoating of upholstery fabrics with acrylic latex reduces seam slippage and generally improves abrasion-resistance and dimensional stability.

Foam backed textiles—two layers of material joined together with stitching, adhesive, or heat—provide a stable backing for loosely constructed surface fabrics. Drapery fabrics use it for insulative lining. Both tricot knits and foams are used as backings. Quilts use three layers and are often hand-stitched or "heat-stitched."

Treatments

Various performance treatments are available for textiles and fabrics. Treatments enhance certain inherent qualities, or add qualities required for special use.

Flame resistance requirements vary with how and where a material is to be used.

Flame-retardance is the property of a material by which, when exposed to a flaming or non-flaming source of ignition, flaming combustion is prevented, terminated or inhibited. Flame retardancy may be achieved by:

- use of fibers which are inherently flame retardant,
- use of fiber modifications that are flame retardant, or
- use of flame retardant coatings.

Flame-retardant coatings modify the original characteristics of a textile to allow it to meet regulations regarding its use in specific applications.

Material	Characteristics
Acetate/Triacetate	Manufactured fiber formed of cellulose acetate. Low cost. Sunlight, moth, mildew, and bacteria resistant. Naturally flame retardant. Low static electric potential. Low abrasion resistance.
Acrylic	Petroleum based synthetic. Moderate tenacity. Resistance to sunlight and abrasion. Moderate dimensional stability.
Cotton	Natural staple fiber. Moderate abrasion resistance. Absorbant. Thermally and electrically conductive. Resistant to alkalis and organic solvents. Low to moderate resiliency, shrinkage and sagging tendencies.
Fiberglass	Manufactured fiber in which the fiber-forming substance is glass. Sunlight, acid and alkali resistant. Flame proof. Low flexibility. No moisture regain.
Flax/Linen	Natural staple fiber. Low elongation. Good abrasion resistance. High moisture regain. Good thermal and electrical conductivity. Fabrics prone to wrinkling.
Jute	Natural staple fiber. Primarily commodity uses prevail. Low elasticity. Low sunlight resistance and colorfastness.
Modacrylic	Synthetic. High bulk. High flame resistance. Moderate resiliency. High elastic recovery. Low melting point. Low abrasion resistance.
Nylon	Synthetic. High tensile strength. Excellent abrasion resistance. Excellent resiliency and appearance retention. May be solution dyed.
Olefin/Polypropylene	Synthetic. Good abrasion resistance, tenacity. Excellent resiliency. Good dimensional stability. Static resistant, excellent resistance to most chemicals. Resists mildew and water-borne stains. Expensive to dye. Difficult to clean .
Polyester/Trevira	Synthetic. Excellent strength. Good abrasion resistance. Resists wrinkling. Permanent body.
Rayon/Viscose	Manufactured fiber made from chemically-prepared cellulose. Soft hand. High moisture regain. Good thermal and electrical conductor. Poor resiliency. Progressive shrinkage. Weakness when wet.
Silk	Natural, continuous filament fiber. Very fine fiber. Soft luster. Moderate to high abrasion resistance. Absorbant. Good heat retention. Dry hand. Medium density. Moderate resistance to wrinkling. Moderate recovery from elongation. Dimensionally stable. Poor electrical conductivity.
Sisal	Natural plant fiber. Very durable. Excellent abrasion resistance.
Wool/Mohair	Natural fiber from fleece. Moderate abrasion resistance. Low tenacity (especially when wet). Good flexibility. High elongation. Highly absorbant. High thermal retention and resiliency. Allergenic potential.

Fig. 18 Textile Selection Criteria Table

Flame test methods are designed to assess the potential flammability of fabrics by simulating real-life conditions. Flame Tunnel Test method ASTM E-84, also known as the Steiner Tunnel Test method, measures the surface burning characteristics of building materials. The testing apparatus is structured to simulate a corridor, and the testing procedures and results are used to assess flame spread and smoke generation. Specified criteria have been developed for various interior space characteristics.

Flame-retardant finishes must be durable (able to withstand 50 washings), non-toxic and non-carcinogenic. The hand and texture should not be changed by the finish, and the finish should have no residual odor. Materials used for this purpose are usually phosphate compounds or inorganic salts. Most of these finishes are not visible but add to the cost of the product.

Anti-microbial finishes inhibit the growth of bacteria and other odor-causing germs, prevent decay and damage from perspiration, control spread of disease, and reduce risk of infection transferal. These finishes are also known as antibacterial, bacteriostatic, germicidal, or antiseptic finishes.

Staph fluid barriers are fabric treatments for healthcare furnishings. The treatment uses an anti-bacterial agent which is self-deodorizing, self-sanitizing, and becomes an integral part of the fabric. Any staph fluid barrier used should be guaranteed for the life of the fabric and approved by the Environmental Protection Agency (EPA).

Vinylized fabrics have the surface laminated with a translucent film of sheeting as a preventive maintenance measure. This treatment slows soil accumulation so that proper maintenance only will be required. Though vinylized fabrics can be washed with mild detergent and warm water, they are not waterproof and are not intended for outdoor installations. The vinylized treatment produces some variation in color and luster.

Soil and stain repellents, used by manufacturers to prevent staining, utilize fluorocarbon compounds that enable fibers to repel or resist soil.

Application Guidelines

The materials presented in this chapter form a diverse group, from which the designer must choose according to functional need, aesthetic preference and availability. Applications Guidelines for floors, walls and ceilings follow which summarize objective characteristics of some of the more common material finishes, so that these materials may be compared on an objective basis.

Floors

Resilient Floor Coverings

Materials	Advantages	Disadvantages	Uses	Relative Cost Factor[1]
Vinyl Composition Tile	Resistant to Abrasion, Oils, Grease, Acids, and Alkalis.	Does Not Tolerate Standing Water.	Good for Most Commercial Installations.	Economical 1.0
Linoleum	Resilient. Resistant to Impact and Abrasion.	Susceptible to Staining.	Moderate-Traffic Public Areas.	Moderate 2.7
Cork	Resilient. Resistant to Impact and Abrasion. Natural Product.	Susceptible to Staining.	Moderate-Traffic Public Areas.	Moderate 3.2
Rubber	Resilient. Resistant to Impact and Abrasion.	Not Resistant to Grease or Chemicals.	General Utility Flooring. Stairs.	Moderate 3.2
Thermoplastic Tile	Resistant to Abrasion.	Sensitive to Fluctuations in Temperature.	General Utility Flooring.	Moderate to Expensive 3.6
Sheet Vinyl	Waterproof. Resistant to Most Chemicals. Weldable.	Requires Fairly Smooth Floor Surface.	Moderate Traffic Areas.	Moderate to Expensive 3.8
Static-Conductive Tile	Dissipates Static Electricity.	Sensitive to Extreme Temperatures.	Hospitals, Operating and Anesthetizing Areas, Computer Rooms, Chemical Laboratories.	Expensive 4.1

[1] Relative to the lowest-cost material solution presented. A cost factor of 3 indicates that the referenced material is approximately three times as expensive as the least-cost material solution shown.

Floors

Hard Floor Coverings

Material	Advantages	Disadvantages	Uses	Relative Cost Factor[1]
Concrete (Untreated)	Non-Slip. Abrasion Resistant. Can be Painted or Treated.	Will Give off Dust If Not Treated. Difficult to Clean.	Utility Flooring.	Economical 1.0
Concrete (Treated)	Nonconductive. Non-Dusting, and Non-Slip. Abrasion Resistant.	Requires Special Materials and Method of Application	Industrial and Manufacturing Areas Where Non-Sparking is Required.	Economical 1.1
Quarry Tile	Waterproof. Resistant to Grease and Liquids.	Non Resilient. May Break under Impact.	Heavy Traffic Areas, Kitchens.	Moderate 5.0
Ceramic Tile (Clay, Porcelain)	Waterproof. Resistant to Most Chemicals.	Cold. May Break under Impact. Glazing may Chip or Crack.	High Moisture Areas. Bathrooms, Kitchens.	Moderate 5.4
Wood	Relatively Easy to Clean and Refinish.	Not Resistant to Abrasion or Moisture.	Dry, Indoor Locations. Homes, Gymnasiums.	Moderate to Expensive 6.4
Brick	Resistant to Abrasion, Moisture, and Heat.	Rough and Uneven Because of Joints. Absorbs Stains.	Decorative.	Expensive 6.8
Terrazzo (All Types)	Durable in Extreme Weather Conditions.	Slippery When Wet.	Heavy Traffic Areas. Stairs, Hospitals.	Expensive 7.8
Stone (Granite, Marble, Slate)	Durable in Extreme Weather Conditions.	Slippery When Wet. Cracks under Impact.	Heavy Traffic Areas. Entries.	Expensive 8.2

[1] Relative to the lowest-cost material solution presented. A cost factor of 3 indicates that the referenced material is approximately three times as expensive as the least-cost material solution shown.

Walls

Material	Advantages	Disadvantages	Uses	Relative Cost Factor[1]
Paint	Inexpensive. Monolithic. Easily Applied and Maintained. Available in a Wide Variety of Colors, Finishes, and Compositions. Flexible.	Tends to Be One-Dimensional. Only as Durable as the Substrate.	Solid Color Walls, Faux Finishes, Trompe l'oeil, Patterns and Graphics.	Economical 1.0
Vinyl Wallcovering	Relatively Easily Applied and Maintained. Available in a Wide Variety of Colors, Patterns, and Textures. Can Conceal Flaws in Substrate. Can Provide Some Acoustical Benefits.	Not Easily Repaired. Susceptible to Delamination.	Public Spaces. Medium Traffic Surfaces.	Moderate 1.6-2.5
Fabric Wallcovering	Relatively Easily Applied and Maintained. Available in a Wide Variety of Colors, Patterns, and Textures. Can Conceal Flaws in Substrate. Can Provide Some Acoustical Benefits.	Not Easily Maintained or Repaired. Susceptible to Raveling, Fraying, and Delamination.	Private Offices and Communal Spaces. Clean, Low-Abuse Areas.	Expensive 5.0-7.3
Ceramic Tile	Impervious. Available in a Wide Variety of Colors, Sizes and Finishes. Extremely Durable.	Expensive. Brittle. Requires Extraordinary Substrate. Can be Perceived as Cold.	Wet Areas, Clean Areas, High Traffic Areas.	Expensive 5.3-7.4

[1] Relative to the lowest-cost material solution presented. A cost factor of 3 indicates that the referenced material is approximately three times as expensive as the least-cost material solution shown.

Ceilings

Material	Advantages	Disadvantages	Uses	Relative Cost Factor[1]
Painted Wallboard or Plaster	Monolithic. Durable. Easily Maintained. Unlimited Color Selection. Wide Variety of Finishes and Textures. Relatively Secure. Provides Good Environmental Separation. Ultimately Flexible.	Limits Accessibility to Ceiling Space.	Areas Where Durability, Cleanability, and Environmental Separation are Priorities, and Accessibility is Not.	Economical 1.0
Acoustic Ceiling Panels	Easily Installed. Relatively Low Initial Cost. Relatively Easily Maintained. Excellent Ceiling Accessibility. Variety of Colors, Textures, and Patterns Available. Easily Integrates HVAC and Lighting Devices.	Not Easily Maintained or Repaired. Susceptible to Moisture, Impact Damage, and Soiling. Not Easily Cleaned.	Areas Not Susceptible to Moisture or Impact.	Moderate 1.2-2.6
Metal Ceilings	Primarily Aesthetic. Defines a Ceiling Look. Can Conceal Mechanical Devices. Available in a Wide Variety of Colors and Patterns. Can Provide Some Acoustical Benefits. Limited Accessibility to Ceiling Space.	Not Easily Repaired. Susceptible to Impact Damage.	Primarily Public Spaces Where Aesthetic is Priority.	Expensive 2.8-3.6

[1] Relative to the lowest-cost material solution presented. A cost factor of 3 indicates that the referenced material is approximately three times as expensive as the least-cost material solution shown.